Amelioration of Soils Based on Remotely Sensed Data

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The planning and execution of investments in the field of amelioration require, first of all, a close examination of the conditions prevailing in the natural environment. Especially important is an estimation of the proportion of soil waters as a factor which limits the applicability of a given area for the maintenance and intensification of plant production.

Each amelioration investment is preceded by hydropedological examinations to determine the necessity of planning amelioration systems.

Nowadays, the methodology of this work makes use of the existing large-scale thematic maps:

- soil-agricultural maps with annexes;
- soil-botanical maps;
- cadastral maps, and
- topographical maps.

An analysis of this material facilitates a preliminary identification of soil-water conditions, which means that supplementary hydropedological research on the area can be planned. On the basis of the results of this research, together with information found in the above-mentioned maps , a soil amelioration map is constructed which contains information serving as a basis for the planning of the technical and economic aspects of amelioration investments.

Hydropedological investigations and the soil amelioration map provide information about:

- the structure of soil utilization;
- the range of soil units of an area larger than one hectare, taking into account the estimation of the water regime;
- the characteristics of the size distribution and soil properties in specific contours;
- the urgency of the investment;
- the estimation of the soil response to drainage.

Recently, remote sensing has been used more widely in soil-water investigations carried out for the purpose of amelioration, due to the greater availability of aerial photographs.

Archival panchromatic photographs taken for the purposes of topographical cartography are mostly used. Photographs taken on flights made specially

for amelioration purposes are rare, since this raises the cost of the investigations.

If aerial photos are available for the area under study, together with proper equipment for their interpretation, they can be used right in the first stage, when preparatory work is carried out which gives shape to the photointerpretational draft on which the borders of grassland soil units and the approximate water regimes of the soil complexes can be mapped. Mapping is the result of an interpretation of the soil surface picture which takes into account both direct and indirect photointerpretation features.

Thanks to the phenomenon of stereoscopy the designer is able to have a special insight into the area under investigation, which is very helpful in determining the direction of runoff for the top waters and in localizing the soil contours of soils which have a very diverse relief.

Field work constitutes the next stage in the preparation of the map. The aim of this work is to identify and verify systematically the previously distinguished soil contours and to clarify any photointerpretational uncertainties, to make descriptions of the soil profiles which characterize the soil-water units interpreted and to take samples for laboratory analyses.

After finishing the field work, and taking into account the results of laboratory analyses, the final version of the soil amelioration map is put forward. The elaboration of such maps using stereoscopic panchromatic aerial photographs helps to:

- decrease the range of field work;
- localize soil pits more accurately;
- distinguish more exactly grasslands, shrubs, forests, etc.;
- describe more precisely the contours of different soils, which leads to a decrease in the area of distinguished soil contours on the maps and in this way increases particularity, as far as the reflection of variables and the differentiation of the soil cover are concerned.

The use of aerial panchromatic photographs makes it possible to increase the standard of the work which are carried out before amelioration, although the use of this method in planning offices meets some difficulties because of:

- formalities connected with the use of aerial photographs;
- the long waiting time for the delivery of the archival pictures that have been ordered;
- the high costs of photographs taken on flights made specially for this purpose, and also because of the necessity to operate special equipment for photointerpretation and the experience required in this field.

In order to eliminate those inconveniences, to facilitate the use of aerial photographs and to increase the quantity of documents which can be processed, a photographic soil-natural environment map has been prepared at the request of the Institute of Geodesy and Cartography. The map is a compilation of three different cartographic materials which, combined, give a logical and quite complex unity. The background of the map, on a scale of 1:5 000, is a transformed, panchromatic photogrametric photograph which is a synthetic picture of the environment with registered and ascertainable assumptions on the interrelation between the elements of the environment. Because the photograph is single and thus does not allow stereoscopic observation*, the level picture /every 1.25 m/ is put on the photograph to make the relief more legible. The third element combined within the map is the whole of the soil-agricultural map with its characteristic symbols and soil unit contours. The map compiled in this way greatly facilitates the interpretation of the scale, which is equivalent to documentation requirements.

The merit of this map is its great amount of detail, high legibility and precision. It also offers the possibility of correcting the borders of

the soil complexes on the basis of information contained in the aerial photograph.

The photographic map makes it possible to introduce a number of streamlined methods which are efficient in making cartographic documentations of the survey carried out before amelioration, since after the field work is over, the thematic content of these may be combined with the photographic background and hypsometry, thus resulting in a new kind of soil-amelioration map and, in consequence, a map of the concept of a proposed amelioration system.

To facilitate an interpretation of the photographic content of the map, a catalogue of the identification of elements of the area is worked out. The elements inventoried are those which were the subject of the survey conducted before amelioration. This catalogue comprises elements of environmental infrastructure and the existing buildings and amelioration constructions.

The Institute of Land Reclamation and Grassland Farming studies the range and outlines a detailed technology for the use of the photographic maps of the soil and natural environment for the surveys which are carried out before amelioration and for the documentations which are worked out before the programme.

Another stage in the facilitation of photointerpretation for amelioration planning should be the replacement of panchromatic photographs by other types of photographs, such as spectrozonal, multispectral, etc. The use of black and white photographs in the infrared range of the spectrum deserves special attention because of their ability to register water conditions and plant differentiation. Nowadays, the Institute of Geodesy and Cartography and the Institute of Land Reclamation and Grassland Farming are investigating the possibility of using multispectral photographs for the inventory and characteristics of grasslands.

This sort of registering makes it possible to accomplish the colour compositions which best reflect certain phenomena of nature, including soil differentiation. The search for underground pipelines in the areas of old disused drainage systems constitutes another problem to be solved with the help of the remote sensing technique.

The investigation of the soil environment also plays an important role in the planning of amelioration. The necessity for such investigations results from the need to conduct general studies requiring more general, synthetic characteristics of the soil-water conditions. Such studies are documented by means of maps on a scale of 1:100 000 and 1:25 000. The Institute for Land Reclamation and Grassland Farming has undertaken to work out preamelioration maps on the above scales on the basis of satellite photographs. The latest generation of satellites now in operation /Landsat TM, SPOT-1/ provides information of such precision that it can be used for the elaboration of an environment map on a general scale, especially with respect to water conditions and soil differentiation. Scientific research has already begun with the help of scientific stations dealing with the interpretation of satellite pictures.

Satellite research promises to solve the problem of the inventory of the elements of the natural environment. This research is characterized by a high degree of changeableness because of the possibility of acquiring one-time information for the territory of the whole country. The remotely sensed data are numerical, so once a technology has been worked out for their interpretation, the automation of this technology will be possible thanks to the use of a microcomputer system. This in turn will considerably shorten the time required to draw up such a map, so that the maps will be more up-to-date. The disposition of satellite pictures and the technique for transforming them

will make it possible in the future to create a system for monitoring amelioration investments from the viewpoint of preserving the ecological balance of the environment.

Summary

The state and future prospects of the use of remote sensing in soil amelioration investigations carried out in Poland are presented in this study.

So far, archival, panchromatic photographs have been used for the purpose of topographical cartography. Photographic maps of the soil and natural environment and a catalogue identifying the elements of the areas which are inventoried serve as an aid for the elaboration of cartographic documentation for pre-amelioration surveys. Later, it is planned to replace panchromatic photos by infrared, spectrozonal and multispectral photographs. An attempt to prepare a pre-amelioration map on scales of 1:100 000 and 1:25 000 has also been made.